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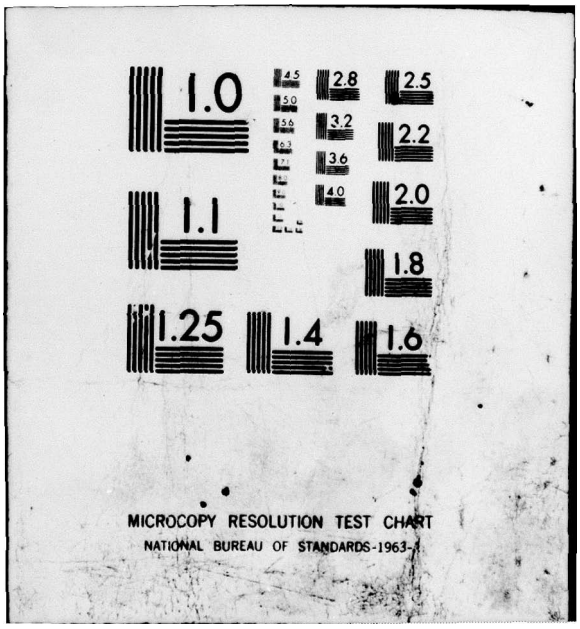
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This document is a trip report associated with work performed on the project entitled "Structure of Highly Ionized Heavy Ions and Associated Collision Phenomena in the MeV/nucleon Range."

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TRIP REPORT

A. Purpose of Trip

The primary purpose of this trip was participation by the principal investigator in the Eleventh International Conference on the Physics of Electronic and Atomic Collisions (Kyoto, Japan, 8/29-9/4/79) as a contributor and delegate, and in the Sixth International Seminar on Ion-Atom Collisions (Tokai-mura,Japan, 9/6-9/7/79) as an invited speaker and delegate. The principal topic of the invited paper was ONR-supported experiments concerning the forward peak in electron emission accompanying ion-atom collisions measured in coincidence with scattered ion charge state. A secondary purpose was acquisition of knowledge of on-going work in other laboratories which will affect the course and conduct of our current and future ONR-supported research, and acquainting other scientists with principal results of our current program of research in atomic collisions physics.

B. Foreign Laboratories and Activities Visited

1. International Conference Center, Kyoto, Japan, 8/29-9/4/1979.
2. Japan Atomic Energy Research Institute, Tokai-mura, Japan, 9/6-9/7/79.

C. Subjects Discussed and Data Acquired

We will make our discussion parallel to items B.1, B.2.

1. The International Conference on the Physics of Electronic and Atomic Collisions (ICPEAC) is held biennially, usually

alternately in Europe and North America. The XI ICPEAC was held in Kyoto, Japan, and was the first such meeting in Asia. Technical information was presented in 26 invited papers, 45 symposia papers, and 527 poster presentations. The conference has grown so large that all contributed papers are now presented in poster sessions. In my opinion, the most important new advance in atomic physics was presented by Dr. H.C. Bryant from the University of New Mexico, Albuquerque. In these experiments the Los Alamos meson factory is used to produce 800 MeV H^- ions, followed by doppler tuning the relative collision energy between photons from a nitrogen laser and the H^- ion by changing the angle of intersection between the two beams. It proves possible to study resonances in the photodetachment spectrum from 1 eV to $\sim$12 eV. Bryant and his coworkers crossed the 800 MeV H^- ion beam at Los Alamos with the output of a nitrogen laser ($h\nu$ = 3.678 eV) to doppler tune the photons by changing the angle between the ion and laser beams. They are able to cover the energy range from 1.1 to 12.5 eV with a resolution of 5.5 meV. They are able to study many of the H^- resonances. By applying magnetic fields they are able to sort out Feshbach resonances that disappear when the magnetic field is switched on. Photodetachment of H in similar circumstances appears to be a realizable short term goal.

Other highlights included laser physics, with emphasis on collision processes in the fields of strong lasers. A.L. Schawlow of Stanford spoke on "Recent Developments in Laser Spectroscopy."

He described many new laser techniques using counter propagating laser beams to remove doppler profiles from absorption spectra. Good lasers can now be made monochromatic to 1 part in 100 million. He mentioned that W.B. Fairbanks has detected < 100 atoms/cm^3 at densities corresponding to - 20° C. Schawlow stressed the importance of the "one atom detection" technique developed at ORNL by G.S. Hurst, M.G. Payne, and M.H. Neyfeh. I.V. Hertel organized a symposium on collision processes in the field of strong lasers. A strong field was defined by Hertel to be the case where the dipole transition strength times the electric field is ~100 MHz times $\sqrt{F}$, where F is the radiation intensity in W/cm^2. For sodium, 1 W/cm^2 is a strong field. The symposium considered only the case where 10^3 W/cm^2 < F < 10^7 W/cm^2. Tom George reviewed the theory of field-assisted and field-modified collisional ionization. John Weiner (Dartmouth College) presented experimental data on "Ionizing Collisions in the Presence of Strong Fields." D. Andrick also spoke at this symposium and presented recent data on experiments involving free-free transitions for electrons. Andrick showed much new data on free-free transitions using a CO_2 laser. He also mentioned a possible experiment in which free-free transitions may be used to heat up electrons in an electron swarm experiment.

New experimental techniques were reported in yet another symposium. S.R. Leone (Joint Institute for Laboratory Astrophysics) has been studying stimulated emission to get electronic

to vibrational (E-V) and vibrational to vibrational (V-V) energy transfer. K. Jung (Kaiserslautern) reviewed techniques in high-resolution electron spectroscopy. Not much has happened since two years ago (or 10 years for that matter). The best resolution is $\sim$5 meV obtained from photodetachment of a negative ion where space charge effects are minimized. A typical resolution is Γ_{FWHM} = 8 meV at 10^{-10} amp. By solving materials problems one might obtain 1 meV energy resolution bands. It would seem that some new ideas are needed in this area. Y. Kaneko (Tokyo Metropolitan University) presented a paper on "Drift Tube Techniques for Ion-Neutral Collisions." With these techniques they are now able to study cross sections at energies below 0.1 eV, and some new information is becoming available.

In the energetic heavy particle collisions field, a very effective review paper by D. Liesen (GSI, Darmstadt) was presented. He focussed on impact parameter dependence of K-vacancy production studies primarily in very heavy systems, work undertaken in support of the search for positron production in heavy ion-atom collisions in the supercritical field regime (electron binding energies > 2 $m_e c^2$). A drastic departure between theory and experiment was noted for $\gtrsim$ 5 MeV/A Pb on curium collisions at impact parameters $\lesssim$ 50 fm. Such discoveries continue to hamper non-nuclear positron production studies.

The author presented three poster contributions concerning

ONR-supported work on the forward peak in electron production in ion-atom collisions. The first concerned the target dependence of an observed left-right asymmetry in the forward peak (supposedly symmetric in first Born approximation) for few MeV/A carbon, oxygen, and silicon ion impact on He, Ne, and Ar. The second concerned application of coincidence techniques to the study of the forward peak, observed in coincidence with the scattered ion. For example, rates for simultaneous 1-, 2-, and 3-electron capture accompanying a continuum capture are measured. The third concerned single K-excitation, single K-ionization, and double K-ionization events accompanying MeV carbon and oxygen in impact on Ar and Ne. Comparisons of absolute cross-sections for such K-ionizing events within the framework of a single experiment have proved possible.

2. At the Sixth ISIAC meeting which convened on site at the Japan Atomic Energy Research Institute, the newest work within the restricted domain of ion-atom collisions was presented and discussed.

The author presented an invited paper on the coincidence aspects of the forward electron production in ion-atom collisions discussed just above (section C1).

N. Stolterfoht discussed post-collision interaction in the angular distribution of Auger-electrons subsequent to vacancy production. A distinct forward-backward asymmetry at low relative velocities is handled by modeling of Stark coupling by receding ions at long range.

H. Schmidt-Bocking, P. Mokler, and G. Soff (GSI-Frankfurt); W. Wolfli (Zurich); and J. Greenberg (Yale) discussed many details of the very heavy ion-atom K-vacancy production problem at 1-10 MeV/A projectile energy. Few results not already contained in the excellent ICPEAC review talk of D. Liesen discussed above came to light. Liesens's talk will appear in the XI ICPEAC invited paper volume, to appear early in 1980.

Y. Gordeev (Leningrad) presented curious results on production of molecular orbital Auger-electrons accompanying low energy (100 keV) Kr-Kr collisions. A central point is that direct coupling to the continuum is deemed to be a dominant source of such Auger electrons. But modeling of the shape and yield of the MO electron distribution appears to require 10^{16} s^{-1} electron hole-filling transition probabilities during such encounters, a value thought unreasonably large (few atomic Augers would emerge if this were so).

A number of papers concerning charge transfer to multiply ionized ions were presented, with emphasis on practical fusion energy applications. The systematics of what is known were admirably renewed by D.H. Crandall, ORNL (from whom copies of the presentation are readily available).

K. Schartner (GSI) and L. Cocke (KSU) spoke concerning production and subsequent collisions of highly ionized recoil ions subsequent to impact by fast, even more highly ionzied

ions. As the recoils are highly charged ($q \gtrsim 10$) but move slowly ($\lesssim 1$ eV energy), charge-exchange phenomena in an unusual regime of the customary charge to velocity relationship can be explored (just as described in the author's book Structure and Collisions of Ions and Atoms, Springer-Verlag, (1978)). The first experiments on such recoils were done with ONR sponsorship in our laboratory during the period 1973-77. But serious experimental problems related to extraction of ions from the collision region in a short time ($\lesssim 1$ μsec) remain.

D. Unusual Observations and Happenings:

None